PRELIMINARY INVESTIGATIONS OF FARMER PRACTICES IN THE CULTIVATION OF THE MAIZE/MILLET INTERCROP IN SOUTHERN MALI

TONY JOHNSON*

A modification and summary of a paper entitled The maize/millet intercrop: farmer practices in south Mali, presented by the author in January 1985 at a workshop on maize/millet organized by ICRISAT/MALI in Sikasso (Mali).

* IDRC agronomist working for l'Institut d'Economie Rurale in Mali

INTRODUCTION

Intercropping maize with pearl millet has become the principal maize production system on dryland farms in southern Mali. This paper attempts to describe how farmers of this ecological zone are cultivating the maize/millet intercrop and presents farm survey data collected by a farming systems research team based in Sikasso.

BACKGROUND

From the time of its introduction from the Ivory Coast (via Sikasso), maize has been cultivated around family dwellings in the villages, where it benefitted from the application of nearly all family organic refuse. When maize began to be cultivated on large fields away from family dwellings (50-75 years ago) it was grown in only the first few years of the cropping cycle (interviews with farmers in Gladie and Monzondougou, 1983 and 1984). Almost always it was intercropped with another cereal, often with cowpea as well. Thus the maize/millet/cowpea intercrop became a widely accepted crop combination well suited to the dryland farming conditions of southern Mali.

In keeping with the indigenous method of cultivating cereals on organic mounds[1] or hills, maize was seeded on their plateaus and when it attained the 2-4 leaf stage the seed mix of millet and cowpea was sown along the sides of the hills. This practice continues today in conjunction with the 'semi-permanent' agrarian system that characterizes much of the savanna region in West Africa (Ruthenberg, 1974). This system entails continued clearing of land and shifting of crops as older fields become infertile and are abandoned to a fallow of between 15-40 years. The typical crop rotation cycle is from 5-8 years including 1-2 years of a legume crop and 4-6 years of cereal or cereal

[1] The hills on which cereals are cultivated are sometimes referred to as organic mounds because during weedings the weeds are incorporated into the new hill and serve as an organic supplement to these soils generally low in organic matter.

and cowpea combinations (DRSPR survey data, 1982, 1984). Maize/millet is rarely cultivated in the same field after the fourth cropping year in this system, and is commonly followed by sorghum or millet and cowpea mixtures. This form of extensive farming allows villages to remain fixed as long as water supply is stable and enough relatively fertile farm land is available.

With the advent of a concerted effort to promote cotton in southern Mali came greater use of animal traction and a more intensive approach to farming. Maize, as well as cotton, began to benefit from better tillage methods. The 'semi-permanent' system, not necessarily appropriate to animal traction systems, is being replaced by the stabilization of fields facilitated by the use of organic and chemical fertilizers and the integration of the livestock and cropping components of the farm. Both the newer, intensive, and the older, extensive, farming practices co-exist at all levels and their relative importance vary from household to household and village to village in the zone.

The maize/millet intercrop was studied in two villages. In Gladié many fields have been continuously cropped for between 10 and 20 years without apparent loss of soil fertility. There, a three year cotton - maize/millet - sorghum rotation has been widely adapted. Almost all human, crop and animal residues are composted and returned to cotton fields before plowing. In addition to the organic fertilizer, which varies from 5-30 tons per hectare, a complete chemical package of N, P and K is applied on the cotton crop. Until the last two years the maize/millet intercrop, which normally follows cotton in the rotation, did not receive fertilizer application. 75% of the farm families in Gladié are equipped with and exploit animal traction technology. A rather elaborate exchange of hand labor against animal traction technology permits many of the remaining 25% of the farm families to get at least one of their fields plowed (Koné, 1984).

A more extensive agrarian system is practiced in the second village, Monzondougou. In many ways it characterizes the problems of transition from traditional hand methods of cultivation to the use of animal drawn equipment and thus is more representative of the actual state of agriculture development in the zone studied. Of the 42 family farms in Monzondougou, 20 possess the nucleus of animal traction technology consisting of 2 oxen and a plow; however, few intensive aspects of crop production are practiced other than shallow plowing of a few fields. At the same time, traditional techniques are employed in other fields by these same families. Whereas in Gladié the agrarian system has been adapted around animal traction technology, the tendency in Monzondougou is to incorporate these newer technologies into the more traditional agrarian system. Maize/millet is cultivated with and without the use of animal traction in both of the villages studied.

METHODOLOGY

The choice of three study villages in southern Mali was based on the intention to gather information from three different agrarian systems found in the zone. Rather loosely defined, these are the following: 'traditional', only manual cultivation techniques are employed; 'intermediate', extensive farming operations often mixing both manual and animal traction techniques; and 'advanced', with a relatively high number of animal traction units and visibly well integrated livestock and cropping components of the farm (DRSPR, 1984). Respectively, the villages are Sakoro[2], Monzondougou and Gladié.

Within the villages studied, farm families were grouped according to criteria based on available family resources, productivity (i.e. self sufficiency in cereals) and whether or not a commercial crop was cultivated (Sy, DRSPR 1982; DRSPR, 1983). 35-50% of the farm families in each village were selected randomly (within the defined groups) to be included in an in-depth survey. The principal objective of the survey was to characterize existing farming systems in the zone by studying both on-farm (crops and livestock) and off-farm activities of the farm families. This information was to serve

[2]Sakoro farmers did not cultivate the maize/millet intercrop and thus only the latter two villages were included in this study of the intercrop.

as benchmark data to evaluate the impact of new technologies.

The crops component of the survey included weekly farm visits as well as qualitative and quantitative observations in the fields of survey farms. Each village had two ennumerators in year round residence. Data was gathered on communal fields of greater than a half hectare[3]. The following information, by field, was collected: the crop; the cropping history of the field (i.e. the duration of the preceeding fallow, the number of years of continuous cropping and the crop rotation for the last five years); soil type; topographical location; surface area; method of soil preparation; sowing, weeding and harvest dates; all crop inputs (quality and quantity); plant density; yield; and agronomic observations concerning pests, erosion and mineral deficiency symptoms. Information on farm family composition and other family resources were included in the larger survey.

Yield estimation was done with the intention of determining the total crop production of the farm. Between 0.5 and 2.0% of the total surface area of the field was sampled by taking 3-7 crop yield cuts along the diagonals of the field. Humidity measurments of maize and millet grain were taken in all study fields. Maize yields were then adjusted to 14% humidity. Pearl millet yields were not adjusted as grain humidity tests showed much less fluctuation (7-12%) than for maize (12-32%).

EMPIRICAL OBSERVATIONS

1. Average production

Total yields (maize + millet) are significantly different between the two villages studied with large variation within each village. Individual fields are larger in the more extensive system of Monzondougou but the average number of hectares per farm family is similar in the two villages. Farmers in

[3] Individual family member's fields, most often less than a half hectare, were not included in the 1983 survey.

Gladié have average combined yields in the intercrop of 2.2 tons per hectare while in Monzondougou farmers average 1.1 T/Ha[4]. Production per family and per worker is higher in Gladié by 70% and 150% respectively.

TABLE N° 1

FIELD SIZE, YIELD AND PRODUCTIVITY OF MAIZE/MILLET IN TWO VILLAGES IN SOUTHERN MALI

VILLAGE	AVE. FIELD SIZE (HA)	AVE. YIELD MAIZE+MILLET (KG/HA)	AVE N° HECTARES PER FARM*	AVE. PROD. PER FARM (KG)	AVE. N° WORKERS PER FARM**	PROD. (KG) MAIZE+MILLET PER WORKER
MONZONDOUGOU	2.1	1,100	2.5	2,750	7.1	400
GLADIE	1.2	2,200	2.2	4,840	5.2	930

*Average number of hectares of maize/millet on the farms which cultivate the intercrop. Farms which do not cultivate maize/millet are not included in this average.

**Average number of workers on farms which cultivate the maize/millet intercrop.

2. Soil preparation

Farmers in the two villages practice three different soil preparation methods for the maize/millet intercrop: fabrication of organic mounds or hills; manual scarification with a hoe (daba); and plowing with oxen. Only the latter two permit seeding in rows. Most farmers in both villages prepare the seedbed for maize/millet by plowing although 40% in Monzondougou and 21% in Gladié use one or the other of the manual methods.

In the following table manual methods of soil preparation are not distinguished from each other. Manual farmers in Gladié often get help from animal traction equipped relatives or neighbors in the village who plow cotton fields for them when their own have been seeded. These manual farmers employ scarification as the soil preparation method, on the maize/millet intercrop succeeding cotton in the crop rotation. In Monzondougou where animal traction is less exploited, all 6 of the manually prepared fields in the study were cultivated on organic hills. Whether the higher average intercrop yields observed

[4] 1983 mean sorghum yields in Monzondougou and Gladié were 551 (16 fields) and 798 (32 fields) KG/HA, respectively. Sorghum is the principal cereal cultivated in the zone and farmers' cultivation practices of this crop is the subject of a later paper.

with scarification are due to relatively higher maize densities (made possible by row seeding), fertility differences or the fact that these fields had been plowed the previous year, is not clear.

TABLE N° 2

THE EFFECT OF PLOWING ON INDIVIDUAL CEREAL YIELDS IN THE MAIZE/MILLET INTERCROP

VILLAGE	SOIL PREPARATION	NUMBER OF FIELDS IN SAMPLE	AVE. MAIZE YIELD(KG/HA)	C.V.%	AVE. MILLET YIELD(KG/HA)	C.V.%
MONZONDOUGOU	PLOWED	9	762	78.7	416	43.8
	UNPLOWED	6	502	49.4	540	44.8
	DIFFERENCE		+260		-124	
GLADIE	PLOWED	26	1730	25.6	704	39.9
	UNPLOWED	7	1081	43.1	691	29.2
	DIFFERENCE		+649		+13	

In Gladie where plowing is relatively deep (15-20 cm), maize yields were significantly different on plowed intercrop fields when compared to nonplowed fields: study fields show 650 KG/HA higher maize yields on plowed fields. Plowing by Monzondougou farmers is less deep (8-10 cm) and most farmers with animal traction make ridges while performing this operation. In this case, plowing is not effectuated directly underneath the ridges and studies show that although overall yields are lower than in flat plowing, ridging is 35-40% faster (Lichte, DRSPR, 1981). There is no significant difference in maize yields between plowed intercrop fields and nonplowed fields in Monzondougou.

Pearl millet yields in the intercrop do not appear to be affected by different soil preparation methods. This observation is important in that as maize yield increases due to deep plowing, millet yield appears to remain stable. Because millet is less responsive to tillage methods and fertility (IRAT/Mali, 1974; Charreau, 1974), it is not generally cultivated in pure stands on intensive animal traction farms in southern Mali. However, millet is greatly appreciated in the diet of farm families in the zone and studies have shown that pearl millet varities cultivated in the south are of high quality

(SRCVO, 1983, 1984). Less variation is observed in yields of the millet component of the intercrop and thus it plays a stabilizing role in total output. This is particularly important in years when maize is adversely affected by irregular or low rainfall.

3. Fertility

The application of fertilizer on the maize/millet intercrop has only recently become a practice by farmers in southern Mali. Fertilizer has been available for cotton since its introduction in the zone as a commercial crop. Farmers often cultivate at least small fields of cotton so as to have access to fertilizer for other crops. A complete fertilizer (14-24-12 plus sulfur and boron) and urea are available and many farmers are applying them in various quantities and combinations on the maize/millet intercrop.

Maize/millet cultivated in a cereal based crop rotation appears to respond favorably to low rates of fertilizer application. Nonparametric 't' test analysis showed a significant yield difference in the 7 fields in this rotation which received fertilizer (an average of 60 KG/HA of one or the other of the fertilizers) when compared with the 9 fields which did not. In this study, average combined intercrop yields were 26% (460 KG/HA) higher on fields which had some fertilizer within the cereal rotation without cotton in it. While the 9 fields without fertilizer average 3.7 years of continuous cropping, the 7 fields with fertilizer average only 2.0. This information tends to confuse differences associated with fertilizer use as soil fertility is also a function of the number of years the field has been cultivated, particularly in the crop rotation without cotton in it.

Within the cotton based crop rotation, maize/millet fields studied did not show a significant yield difference between those which received fertilizer and those which did not. On the average, the intercrop fields in the 2 year rotation of cotton-maize/millet have been continuously cropped for 8.8 years while fields in the 3 year cotton-maize/millet-sorghum rotation have been cropped for 12.4 years. A favorable rotation effect on the intercrop must be noted on these farms as study results indicate a stability in sustained crop yields during many years of the rotation.

TABLE Nº 3

THE EFFECT OF FERTILIZER ON COMBINED YIELDS OF MAIZE/MILLET IN 3 CROP ROTATIONS

Rotation 1: all crop rotations without cotton.
Rotation 2: two year rotation of cotton-maize/millet.
Rotation 3: three year rotation of cotton-maize/millet-sorghum.

ROTATION AND FERTILIZER STATUS	NUMBER OF FIELDS SAMPLED	AVERAGE COMBINED YIELD MAIZE/MILLET (KG/HA)	NUMBER OF YEARS IN CONTINUOUS CROPPING
Rotation 1	16		3.0
with fertilizer	7	2203	2.0
without fertilizer	9	1743	3.7
difference		+460	
Rotation 2	11		8.8
with fertilizer	7	2454	8.4
without fertilizer	4	2233	9.5
difference		+221	
Rotation 3	9		12.4
with fertilizer	4	2433	12.8
without fertilizer	5	2486	12.0
difference		- 53	

4. Varieties, sowing and harvest dates and crop cycles

Farmers in both of the villages studied sow the maize component of the intercrop as soon as rains permit soil preparation. In 1983, rains were slow in establishing adaquate soil humidity and farmers were behind in sowing maize. The midpoint maize seeding date (half of the fields had been planted) in Monzondougou was June 5, while in Gladié it was 8 days later. See rainfall for the two villages on the accompanying graphs.

Millet was seeded on the average 26-30 days after maize. Farmers in both villages install the millet component in alternating rows with maize. Even though there were 8 days average difference in maize seeding dates between the two villages, average millet seeding dates were only 1 day apart on July 6 and 7 in Monzondougou and Gladié, respectively.

The maize cycle from seeding to harvest is 100 days in Monzondougou while in Gladié the average is 108 days. Pearl millet varieties used by farmers in the intercrop are long cycle types. The average number of days from seeding to harvest of these millets is 148 days in Monzondougou and 149 in Gladié.

TABLE N° 4

SEEDING DATES, HARVEST DATES AND CROP CYCLES OF THE MAIZE/MILLET INTERCROP IN TWO VILLAGES[5]

	MONZONDOUGOU	GLADIE
MAIZE SEEDING DATE		
EARLIEST	MAY 17	JUNE 2
LATEST	JULY 4	JULY 8
MIDPOINT	JUNE 5	JUNE 13
STANDARD DEVIATION	15.1 DAYS	7.7 DAYS
MILLET SEEDING DATE		
EARLIEST	JUNE 16	JUNE 29
LATEST	JULY 25	JULY 23
MIDPOINT	JULY 6	JULY 7
STANDARD DEVIATION	13.5 DAYS	6.2 DAYS
SEEDING DATE DIFFERENCE OF TWO CROPS		
LEAST	15 DAYS	14 DAYS
MOST	58 DAYS	33 DAYS
MEAN	30 DAYS	26 DAYS
STANDARD DEVIATION	11.5 DAYS	4.6 DAYS
MAIZE HARVEST DATE		
EARLIEST	AUGUST 20	SEPTEMBER 10
LATEST	SEPTEMBER 29	OCTOBER 27
MIDPOINT	SEPTEMBER 13	SEPTEMBER 29
STANDARD DEVIATION	13.7 DAYS	9.1 DAYS
MILLET HARVEST DATE		
EARLIEST	NOVEMBER 21	NOVEMBER 26
LATEST	DECEMBER 15	DECEMBER 13
MIDPOINT	DECEMBER 2	DECEMBER 4
STANDARD DEVIATION	5.9 DAYS	5.5 DAYS
MAIZE CYCLE		
MINIMUM	78 DAYS	91 DAYS
MAXIMUM	126 DAYS	140 DAYS
MEAN	100 DAYS	108 DAYS
STANDARD DEVIATION	11.5 DAYS	8.2 DAYS
MILLET CYCLE		
MINIMUM	121 DAYS	136 DAYS
MAXIMUM	177 DAYS	168 DAYS
MEAN	149 DAYS	148 DAYS
STANDARD DEVIATION	17.2 DAYS	7.2 DAYS

[5] Data from the 1983 growing season

Farmers exhibit a flexibility in the intercrop management as they appear to select millet varieties depending on how soon the maize is seeded and thus how soon the millet component may be added. Data analyses indicate a negative correlation between millet yield and millet seeding date in 1983 (higher yields were in earlier seeded millet) and lower maize yields when the millet seeding date approached that of maize. Confidence errors were 1% and 5%, respectively. When rains were late in Gladié, 4 of the farmers who generally intercrop maize with millet, made the management decision to intercrop maize with sorghum because the maize component was already seeded late and sorghum varieties are of shorter cycle than millets in the zone.

In Monzondougou, 50% of the maize in the intercrop was harvested by September 13 while in Gladié this point was reached on September 29. The 16 day difference in maize harvest dates between villages is explained by the average of 8 days difference in seeding and the use of maize varieties that are on the average, 8 days longer to maturity in Gladié. 50% of the millet in the intercrop was harvested by December 2 and 4 in Monzondougou and Gladié, respectively. In the intercropped fields studied, an average of 70 days difference in the harvest dates of the two crop components is noted.

TABLE N° 5

MAIZE VARIETIES IN THE MAIZE/MILLET INTERCROP IN TWO VILLAGES

VILLAGE	VARIETY	NUMBER OF FIELDS IN THE SAMPLE	CYCLE MEAN*	YIELD MEAN (KG/HA)
MONZONDOUGOU	KABABA	9	99 DAYS	765
	KABABABLE	4	100 DAYS	263
	TIEMANTIE	2	103 DAYS	611
GLADIE	WORODOUGOUKA	24	108 DAYS	1739
	KABADIE	12	107 DAYS	1221

* The mean number of days from sowing to harvest. Information on flowering dates and physiological maturity was not available

TABLE N° 6

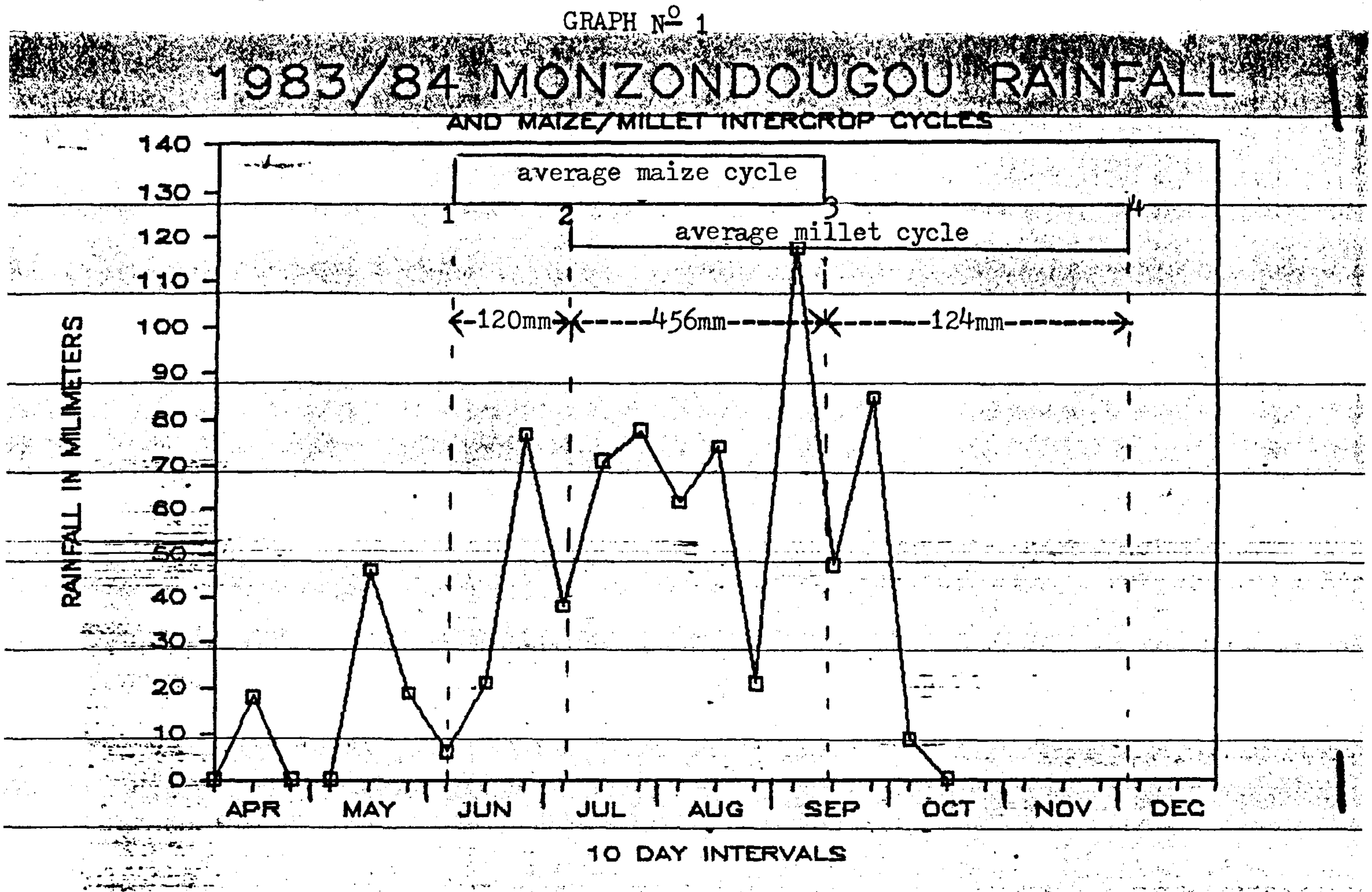
PEARL MILLET VARIETIES IN THE MAIZE/MILLET INTERCROP IN TWO VILLAGES

VILLAGE	VARIETY	NUMBER OF FIELDS IN THE SAMPLE	CYCLE MEAN*	YIELD MEAN (KG/HA)
MONZONDOUGOU	DJEGUIN	8	146 DAYS	333
	SAGNOBA	4	158 DAYS	624
	SANKO	3	146 DAYS	570
GLADIE	SAGNOBA	32	148 DAYS	688

* The mean number of days from sowing to harvest.

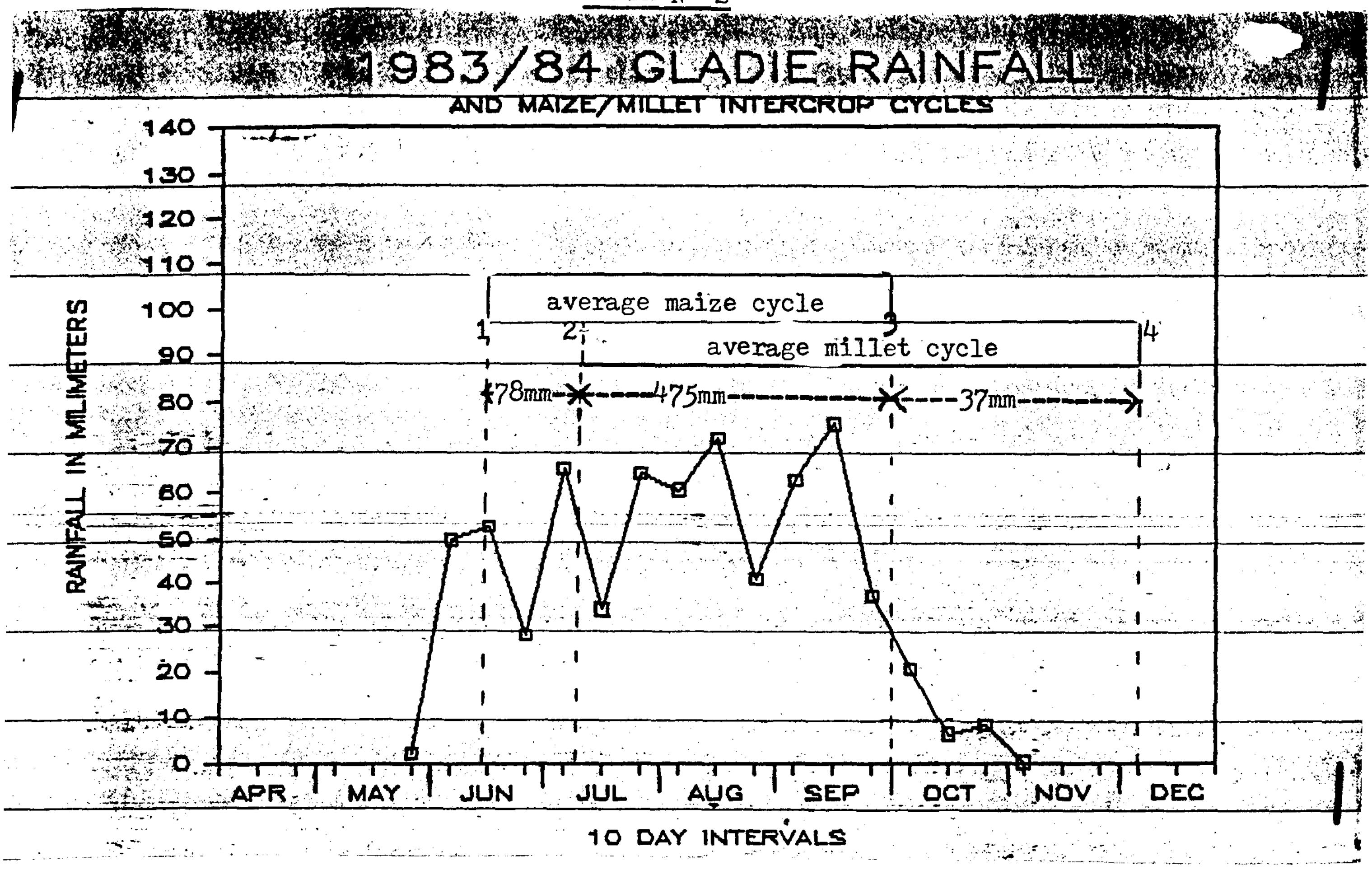
Total annual rainfall in Monzondougou and Gladié was 787 and 676 mm, respectively. According to midpoint seeding and harvest dates of the two crops, 89 and 87% of the total annual rainfall was received by the intercrop in the two villages studied (and was thus potentially available).

GRAPH N° 1



1- Midpoint date when 50% of the maize had been seeded in the intercrop was on June 5.
2- Midpoint date of millet seeded in the intercrop was on July 6.
3- Maize in half of the fields studied had been harvested on September 13.
4- Pearl millet had been harvested in half of the fields studied on December 2.

GRAPH N° 2



1- Maize had been seeded in half of the fields studied on June 13.
2- Pearl millet had been seeded in half of the fields on July 7.
3- Maize harvest completed in half of the fields studied on September 29.
4- Millet harvested in half of the fields studied on December 4.

5. Crop densities

Maize and millet densities on intercropped fields were significantly different between the two villages: plant (maize) and pocket (millet) densities were generally lower in Monzondougou when compared to Gladié.

In Monzondougou, mean maize density was 13,615 plants per hectare with a standard deviation of 9,783. Although the variance in maize density was large (C.V. = 72%), correlation analysis of the relationship between maize density and maize yield in the intercrop showed a strong positive correlation (refer to the following two tables) between these two variables. Millet density in these same fields had a mean of 10,588 pockets per hectare and a standard deviation of 2,796. Analysis showed only a weak positive correlation (r = .133) between millet density and millet yield in the intercrop.

In Gladié, mean maize density was 18,744 plants per hectare with a standard deviation of 3,603. Mean millet density was 20,874 pockets per hectare with a standard deviation of 5,592. Analysis showed that maize density and maize yield were positively correlated (P% = 5.37) while millet density and millet yield were highly negatively correlated (P% = .05). Table N° 8 below shows the significant correlations between density and yield of the intercrop components in the two villages studied.

TABLE N° 7

MAIZE AND PEARL MILLET INTERCROP DENSITIES

	MONZONDOUGOU (15 FIELDS)	GLADIE (31 FIELDS)	ALL 46 FIELDS
MAIZE DENSITY (PL/HA)			
MINIMUM	2,070	9,600	2,070
MAXIMUM	27,840	25,920	27,840
MEAN	13,615	18,744	17,071
STANDARD DEVIATION	9,783	3,603	6,659
PEARL MILLET DENSITY (POCKETS/HA)*			
MINIMUM	7,600	13,200	7,600
MAXIMUM	16,800	31,440	31,440
MEAN	10,588	20,874	17,520
STANDARD DEVIATION	2,796	5,592	6,859

* Millet density is given in pockets per hectare as tillering by this crop made plant counts difficult to co-ordinate because of seeding date variability.

TABLE N° 8

CORRELATION ANALYSES

OF INTERCROP DENSITY AND YIELD IN TWO VILLAGES IN SOUTHERN MALI

CORRELATION DESCRIPTION	n	r	P(%)	LINNEAR REGRESSION MODEL EQUATION
MONZONDOUGOU				
Intercrop maize density in PL/HA(x) and maize yield in KG/HA(y)	15	.651	.85	y = 210 + .03x
GLADIE				
Intercrop maize density in PL/HA(x) and maize yield in KG/HA(y)	31	.346	5.37	y = 738 + .05x
Intercrop millet density in POCKETS/HA(x) and millet yield in KG/HA(y)	31	-.608	.05	y = 1290 - .03x

Within the range of intercrop densities in the fields studied, no significant correlation was observed between the increase of the density of one cereal and the decrease in yield of the other. Farmers appear to be maximizing production of both of the intercrop components. While maize density is generally positively correlated to maize yield in the intercrop, only in Gladié (where the millet density mean is approximately double that in Monzondougou) is millet density negatively correlated to millet yield. Correlation coefficients (r values) were higher for linnear regression models than for nonlinnear models within the range of densities and yields in farmers fields.

6. The use of herbicide on the intercrop

Farmers in the two villages studied, who cultivate the intercrop in rows (85%) rather than on organic hills (15%), alternate one row of maize with one row of millet. Present animal traction cultivation equipment which is available to southern Mali farmers, permits only one mechanical weeding of the intercrop, normally done on the maize just before seeding millet. After the installation of the second crop, millet, further weeding operations (with this spacial arrangement of the two crops) must be done by hand.[6]

The first herbicide available in the zone for maize production was Atrazine which was introduced in 1980. Farmers in the more intensive agrarian system of Gladié very quickly adapted the technology to their maize/millet intercrop. An estimated 40% of these farmers used this herbicide on maize/millet fields in that year. In 1983, Primagram (4 liters/HA) replaced Atrazine. Of the fields studied, 55% in Gladié received Primagram application although at lower than the recommended dose for sole crop maize. The average rate of application on those fields where herbicide was employed, was 2.4 liters per hectare. No visual symptoms of herbicide toxicity were observed on the millet

[6] Farmers somewhat north of the zone studied often cultivate the two crops in the same row. In that case the millet is seeded between the maize plants and mechanical cultivation techniques continue until the height of the maize plants prohibits further passage of animal drawn equipment.

seeded 25-30 days after herbicide application.

Intercrop yield in fields sprayed with herbicide was similar to the yield in fields in which no herbicide was employed. Results of the study show that average field size was 40% larger (1.4 HA) where herbicide was used than where it was not (1.0 HA). This indicates a tendency towards extensification with an increase in total production as fields are enlarged without a corresponding decrease in yield.

CONCLUSION

Farmers in southern Mali are cultivating the maize/millet intercrop when and where soil fertility permits: on animal traction intensive farms in a cotton based crop rotation; and on more extensive farms during the first couple of years of the cropping cycle in a cereal based rotation.

Local varieties of both maize and millet are utilized in the intercrop. Maize varieties are of medium to long duration (97-120 days) while pearl millet varieties are long cycle types of 140-155 days from seeding to harvest. This combination of crop cycles utilized 85% of the available annual moisture in 1983 while they occupied intercropped fields for 6 months.

In the fields studied, maize density (mean) is only 43% of the 40,000 plants per hectare recommended by research and development agencies for the intercrop. Millet density is generally higher in farmers' fields than anticipated. One explanation for this is that while research and extension realize that potential increases in total intercrop production will be made by increasing maize yield (often with the result of decreasing millet yields), farmers are unwilling to accept this trade off. Farmers in the two villages studied have persisted in cultivating the maize/millet intercrop when both research and extension agencies were trying to replace this intercrop with sole crop maize.

The crop rotation must be taken into consideration if research is to take a role in making recommendations on intercrop fertility. Where cotton is cultivated in the rotation, organic matter and phosphate applications (on cotton) will affect fertilizer levels on maize/millet. Little information is presently available on viable crop rotations in the zone which do not include cotton and research is needed on such rotations. These might include sorghum and legumes (either intercropped or as sole crops) and short fallows. Farmer feedback will be essential so that proposed crop rotations and corresponding input levels be practical in the farming systems in the zone.

Present animal traction technology used by farmers limits mechanical intervention in the intercrop after millet has been seeded between the rows of maize. Many farmers on intensified animal traction farms reduce manual weeding by using a maize herbicide on the intercrop without apparent negative effect on the millet which is seeded 25-30 days after the maize.

Farmers appear to be flexible in their management of the intercrop, adjusting varieties, seeding dates and even cereal species (using sorghum instead of millet) as a function of the rainy season. Intercrop management should be studied over several years in order to understand more fully its elasticity with respect to varying rainfall.

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